PATENT ABSTRACTS OF JAPAN

(11)Publication number : **2001-090733**
(43)Date of publication of application : **03.04.2001**

(51)Int.CI. F16C 33/14
F16C 17/10
F16C 33/10
G01F 23/292
// G01C 3/06

(21)Application number : **11-271666**
(22)Date of filing : **27.09.1999**

(71)Applicant : **SANKYO SEIKI MFG CO LTD**
(72)Inventor : **KONDO HIDEYUKI**
NARITA TAKAYUKI
GOMYO MASATO

(54) METHOD OF MANUFACTURING FOR DYNAMIC PRESSURE BEARING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a manufacturing method for a dynamic pressure bearing device capable of correctly adjusting and controlling the position of a liquid surface of lubricating oil in a dynamic pressure bearing without causing oil leak or seizure.

SOLUTION: In this manufacturing method for a dynamic pressure bearing device in which a shaft 1 is relatively rotatably supported by dynamic pressure action of relative rotation between the shaft 1 and a bearing 4, an automatic focusing device to determine a focusing position based on an image obtained from a microscope 51 is used, an objective lens of the microscope 51 is moved, focusing positions of an end surface of the bearing 4 in a shaft direction and a liquid surface of lubricating oil 6 formed between the shaft 1 and the bearing 4 are determined, and the position of the liquid surface of the lubricating oil 6 to the end surface of the bearing 4 in the shaft direction is determined based on position difference of the objective lens between the respective focusing positions, thereby the liquid surface position of the lubricating oil 6 is set to a specified position.

CLAIMS

[Claim(s)]

[Claim 1] While having the bearing supported possible [relative rotation of a shaft and this shaft], forming the slot for dynamic pressure generating in one side of the above-mentioned shaft and bearing and forming dynamic pressure bearing In the manufacture method of the hydrodynamic bearing equipment which fills up the above-mentioned dynamic pressure bearing with lubricous oil, and was supported possible [relative rotation of the above-mentioned shaft] by the dynamic pressure operation by relative rotation with the above-mentioned shaft and bearing An end face [in / the shaft orientations of the above-mentioned bearing / the objective lens of the above-mentioned microscope is moved using the automatic-focus equipment which asks for a focus position from the picture acquired from a microscope, and], It asks for each focus position with the oil level of the above-mentioned lubricous oil formed between the above-mentioned shaft and bearing. The manufacture method of the hydrodynamic bearing equipment characterized by asking for the position of the oil level of the above-mentioned lubricous oil to the end face in the shaft orientations of the

above-mentioned bearing from the position difference of the above-mentioned objective lens in the focus position of each above, and making the oil-level position of the above-mentioned lubricous oil into a position.

[Claim 2] The manufacture method of the hydrodynamic bearing equipment according to claim 1 characterized by locating the oil level of the aforementioned lubricous oil in the meniscus seal section located in the ramp in which it is formed, and which the interval of the aforementioned shaft and bearing becomes so that it may expand gradually.

[Claim 3] The manufacture method of the hydrodynamic-bearing equipment according to claim 2 characterized by to set up so that each of an end face [in / the shaft orientations of the above-mentioned bearing / for the visual field of the above-mentioned microscope] and the oil level of the above-mentioned lubricous oil may be included, while having incorporated the picture acquired from the aforementioned microscope to automatic-focus equipment through the camera, and to be set up the focal area to the end face in the direction of bearing of the above-mentioned bearing, and the focal area to the oil level of the above-mentioned lubricous oil in

[Claim 4] The manufacture method of the hydrodynamic bearing equipment according to claim 3 which dynamic pressure bearing is formed inside the aforementioned ramp, is constituted so that the lubricous oil by which it is placed between these dynamic pressure bearings at the aforementioned meniscus seal section may be supplied, and is characterized by the bird clapper.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the manufacture method of hydrodynamic bearing equipment applicable to for example, the motor for hard disk drives etc.

[0002]

[Description of the Prior Art] Generally the meniscus seal inserted into the shaft 11 as shown in drawing 9 , and inclined plane 4C formed in the sleeve 4 as oil seal in an oil dynamic pressure motor is known. In a meniscus seal, the height (the size X from the point A on the end face of a sleeve 4 to the point B on an oil level) of the oil level of the oil 6 in inclined plane 4C is a size important when manufacturing a motor. A size X is small, namely, if an oil level is high, oil will become easy to leak out of the meniscus section. Conversely, since there are few amounts of oil of a low and meniscus circles, immediately, oil will evaporate, it will be drained, a shaft 11 and a sleeve 4 will be burn, and the life of bearing will become [a size X] large short. [oil level] For this reason, it is necessary to manufacture hydrodynamic bearing equipment, measuring a size X and managing the height of an oil level.

[0003] In order to measure with a laser measuring machine, the diameter of a laser spot beyond phi0.5mm was needed, and although using a laser measuring machine in order to measure the above-mentioned size X directly was also considered, 1 micrometer - 10 micrometers and since the size inside an actual meniscus was narrow, it was not able to measure a size X directly.

[0004] Moreover, the method of measuring the width of face of the reflected light of the shape of a ring more than one seem to be conventionally shown in drawing 10 on an oil level, and considering as substitution of the above-mentioned size X was performed. The reflected light of an oil oil level seemed to be shown in drawing 10 (a) in the shape of [two or more] a ring, and since this width of face had a size X and correlation, it was measuring this width of face as a substitution size of a size X. This method reads the difference of the focal position of A points and the B point in drawing 9 with a magnetic scale etc. However, when actually measured, there was a problem that the directions which the reflected light of an oil oil level has completely differed, and exact measurement could not do them each time, by the scattered reflection of the light from the metal part of how to apply light or the circumference. Moreover, since the actual oil oil level was curving by capillarity, it was the actual condition which cannot be measured in precision sufficient by the measuring method in which light is reflected fundamentally.

[0005]

[Problem(s) to be Solved by the Invention] It was made in order that this invention might cancel the trouble of the above conventional technology, and the position of the oil level of the lubricous oil of a hydrodynamic bearing can be adjusted and managed correctly, and it aims at offering the manufacture method of hydrodynamic bearing equipment that neither oil leakage nor seizure happens.

[0006]

[Means for Solving the Problem] While invention according to claim 1 is equipped with the bearing supported possible [relative rotation of a shaft and this shaft], forming the slot for dynamic pressure generating in one side of the above-mentioned shaft and bearing and forming dynamic pressure bearing In the manufacture method of the hydrodynamic bearing equipment which fills up the above-mentioned dynamic pressure bearing with lubricous oil, and was supported possible [relative rotation of the above-mentioned shaft] by the dynamic pressure operation by relative rotation with the above-mentioned shaft and bearing An end face [in / the shaft orientations of the above-mentioned bearing / the objective lens of the above-mentioned microscope is moved using the automatic-focus equipment which asks for a focus position from the picture acquired from a microscope, and], It asks for each focus position with the oil level of the above-mentioned lubricous oil formed between the above-mentioned shaft and bearing. It asks for the position of the oil level of the above-mentioned lubricous oil to the end face in the shaft orientations of the above-mentioned bearing from the position difference of the above-mentioned objective lens in the focus position of each above, and is characterized by making the oil-level position of the above-mentioned lubricous oil into a position.

[0007] Invention according to claim 2 is characterized by making it located in the meniscus seal section located in the ramp which is formed and becomes so that the interval of the aforementioned shaft and bearing may expand the oil level of lubricous oil gradually in the manufacture method of hydrodynamic bearing equipment according to claim 1.

[0008] While invention according to claim 3 has incorporated the picture acquired from a microscope to automatic-focus equipment through the camera in the manufacture method of hydrodynamic bearing equipment according to claim 2 It sets up so that each of an end face [in / the shaft orientations of the above-mentioned bearing / for the visual field of the above-mentioned microscope] and the oil level of the above-mentioned lubricous oil may be included. It is characterized by setting up the focal area to the end face in the direction of bearing of the above-mentioned bearing, and the focal area to the oil level of the above-mentioned lubricous oil in the above-mentioned visual field.

[0009] In the manufacture method of hydrodynamic bearing equipment according to claim 3, dynamic pressure bearing is formed inside a ramp, invention according to claim 4 is constituted so that the lubricous oil by which it is placed between these dynamic pressure bearings at the aforementioned meniscus seal section may be supplied, and it is characterized by the bird clapper.

[0010]

[Embodiments of the Invention] Hereafter, the gestalt of implementation of the manufacture method of the hydrodynamic bearing equipment concerning this invention is explained, referring to a drawing. In case especially this invention sets up the oil oil-level position of meniscus circles established in bearing, it is characterized by raising the accuracy of measurement, and shows an example of the motor which can apply the hydrodynamic bearing equipment manufactured by this invention to drawing 1 . In addition, although the motor shown in drawing 1 is constituted as a disk drive motor which carries out the rotation drive of the disks, such as a hard disk, the hydrodynamic bearing equipment manufactured by the method concerning this invention is applicable also as hydrodynamic bearing equipment of various devices other than a disk drive motor.

[0011] The hub 2 for attaching a disk is fixed to the axis of rotation 1 by pressing the feed hole fit in the upper-limit section of the axis of rotation 1. By having a feed hole, the axis of rotation 1 is inserted in the above-mentioned feed hole of a sleeve 4 which has opening to ends, and is beforehand attached in the sleeve 4. The radial hydrodynamic bearing 38 is formed between the above-mentioned axis of rotation 1 and a sleeve 4, and the axis of rotation 1 is supported free [rotation] by the dynamic pressure operation by this hydrodynamic bearing. The thrust hydrodynamic bearing 39 is formed between the thrust plate 5 pressed fit in the soffit section of the axis of rotation 1, and the counter plate 16 as covering device material which was put on soffit opening of a sleeve 4 and closed the soffit of a sleeve 4, and between the thrust plate 5 and the thrust plate opposite side of a sleeve, and thrust loading is supported.

[0012] The feed hole of the laminating core 12 is fixed to the periphery of a sleeve 4 by pressing fit etc. from the sleeve 4 bottom, and the sleeve 4 is being further fixed to the base 8 by pressing fit with the periphery soffit section and feed hole of the base 8 etc. The predetermined interval is taken between upper-limit side 4A of a sleeve 4, and the inferior surface of tongue 17 of the hub 2 which counters this. The interval of the inferior surface of tongue 17 of this hub 2 and upper-limit side 4A of a sleeve 4 is larger than the bearing interval of a hydrodynamic bearing 38. furthermore, the upper-limit side of a sleeve 4 and the above-mentioned inferior surface of tongue 17 of the hub 2 which counters are formed in a loose taper side -- having -- **** -- the above -- the interval of a hub 2 and the end face of a sleeve 4 is formed so that it may become large one by one toward a radial outside rather than a hydrodynamic bearing 38 side Moreover, feed-hole upper-limit section 4B of a sleeve 4 is also formed in the shape of a taper, and the meniscus section 45 of a cross-section wedge shape is formed between the periphery

sides of the axis of rotation 1. the space which this meniscus section 45 has spread toward the lower shell top, and constitutes a hydrodynamic bearing, and the above -- it is connected with the space of a hub 2 and the end face of a sleeve 4

[0013] There is a minute crevice, a minute crevice is between the periphery side of the axis of rotation 1, and the inner skin of a sleeve 4, and there is a minute crevice also between the inferior surface of tongue of the above-mentioned thrust plate 5, and the upper surface of a counter plate 16 also between the upper surface of the thrust plate 5, and the opposite side of a sleeve 4 further. Oil is made placed between the crevice between the periphery side of the above-mentioned axis of rotation 1, and the inner skin of a sleeve 4, the crevice between the upper surface of the thrust plate 5, and the opposite side of a sleeve 4, and the crevice between the inferior surface of tongue of the thrust plate 5, and the upper surface of a counter plate 16. By mediation of this oil, a radial hydrodynamic bearing will be constituted between the periphery side of the axis of rotation 1, and the inner skin of a sleeve 4, and the upper surface of the thrust plate 5 and the thrust plate opposite side of a sleeve 4 will constitute a top thrust hydrodynamic bearing, and a bottom thrust hydrodynamic bearing will be constituted between the inferior surface of tongue of the thrust plate 5, and the upper surface of a counter plate 16. If the axis of rotation 1 rotates, the axis of rotation 1 will be supported free [rotation], without contacting a sleeve 4 mechanically also in the thrust direction also in the direction of a radial.

[0014] The cylinder-like Rota magnet 7 is inserted in the peripheral wall inner skin of a hub 2, and it fixes to a hub 2 by adhesion etc. The Rota magnet 7 is beforehand magnetized by turns by the hoop direction at the fixed interval at NS. Thus, bearing and the Rota group are constituted.

[0015] The flexible wiring substrate 10 is arranged in the slot formed in the undersurface of the base 8, and from the base 8 bottom, the insulating paper 11 is dropped and it is arranged at the inner bottom of the base 8. The base group is constituted by these.

[0016] Moreover, a wire is wound around each salient pole of the laminating core 12, this is made into a drive coil 13, and the core coil group is constituted. Soldering of each drive coil terminal of a core coil group is carried out to the predetermined circuit pattern of the above-mentioned flexible wiring substrate 10. Furthermore, the drawer portion and others of the flexible wiring substrate 10 are closed by the resin. Thus, the base and the stator group are constituted.

[0017] The aforementioned bearing and the Rota group are attached to the above-mentioned base and a stator group. A sleeve 4 is inserted in the feed hole of the laminating core 12 with [this] a group from the upper part of the base and a stator

group, and it inserts the above-mentioned sleeve 4 in the inner circumference side of the base 8 further. Thus, the motor for hard disk drives is constituted. The feed hole of the disk which is not illustrated is inserted in the cylinder-like fuselage portion of a hub 2, and a disk is carried with one sheet or two or more sheets, and a proper spacer on the aforementioned disk loading side 3. the tap formed in the axis of rotation -- a disk is attached in a hub and one possible [rotation] by attaching a clamp member using a hole etc. and pushing the above-mentioned disk against the disk loading side 3 by this clamp member

[0018] The hydrodynamic bearing manufacture method concerning this invention is a manufacturing method of a hydrodynamic bearing applicable to the above motors, for example. Optical measurement of the oil oil-level position of meniscus circles formed of the axis of rotation 1 prepared especially in bearing and inclined plane 4C is enabled. It is characterized by making the accuracy of measurement high, as shown in drawing 2 , the oil level of the lubricous oil 6 of the meniscus section 45 prepared in bearing is observed under a microscope, and the height of a fuel level is measured using the function of the automatic-focusing equipment formed in the microscope. Each measuring equipment, such as a microscope used for measurement below, is explained.

[0019] An example of the microscope which can be used for this invention at drawing 3 is shown. The camera cable 41 is attached in the upper-limit side side of the cylinder part 40 in which the CCD camera was built. The microscope unit 42 is attached in the field by the side of the soffit of a cylinder part 40, a lighting system 43 is formed in the lower part section of this microscope unit 42, and the objective lens 44 is attached in the edge.

[0020] The above-mentioned microscope unit 42 is fixed to Z stage 60 which can move in the vertical direction, the microscope unit 42 is moved in the vertical direction by rotation of the stepping motor which is not illustrated, and focus operation is performed.

[0021] The example of composition of the whole measuring equipment which can be used for this invention at drawing 4 is shown. Two cables 53 and 54 are connected with the television camera 52 attached in the upper part of a microscope 51. It connects with the automatic-focusing equipment 57 by which one cable 53 was connected to the camera power supply 55, and the cable 54 of another side was connected to the personal computer 56. Automatic-focusing equipment 57 is connected also to the TV monitor 64. From automatic-focusing equipment 57, the cable towards the stepping motor driver 58 is connected, and this stepping driver 58 is connected to the stepping motor 59. According to rotation of a stepping motor 59, Z stage 60 can move in the vertical direction.

[0022] Moreover, the fiber lighting system 61 is connected to the lens-barrel section of a microscope 51, and illuminance adjustment is performed from the fiber lighting system

61 according to the directions sent from a personal computer 56 to obtain the best illuminance for microscope oil-level observation. Position NINGU of the oil level of the meniscus section of a hydrodynamic bearing is carried out at the work holder 63 on X-Y stage 62, and oil-level position measurement of lubricous oil is performed by the measurement procedure mentioned later.

[0023] The measurement procedure of the oil-level position of the meniscus section in the manufacture method of the hydrodynamic bearing equipment applied to this invention below is explained. A visual field setup of a microscope is shown in drawing 5 , and the block diagram of the measuring equipment for oil-level position measurement is shown in drawing 6 . In addition, drawing 5 shows the meniscus section and the microscope visual field of bearing simultaneously as a sectional side elevation and a plan. Into the camera visual field of a microscope, both the oil level (area B) of lubricous oil 6 and the upper surface (area A) of a sleeve 4 are put in first. According to the control signal from a personal computer, automatic-focusing doubling operation of a microscope is performed to the beginning in A on a sleeve 4 (area A). Next, according to the control signal from a personal computer, automatic-focusing doubling operation of a microscope is performed in B on an oil level (area B). In addition, it faces doubling a focus and carries on the stage which slides a hydrodynamic bearing in the vertical direction, and a focus is doubled, rotating a stepping motor and moving a stage.

[0024] The pulse number of delivery of the stepping motor from the position of A points with which the focus was doubled first to the position of B points which doubled the focus with the degree is counted, and it downloads to a personal computer by making this into the number of steps, and if the difference for two points is calculated and it displays on monitor display, the distance of the depth direction from A points to B points is known immediately. In addition, it is good to repeat automatic-focusing doubling operation and to equalize a numeric value if needed. Thus, since the oil-level position of the meniscus section can be adjusted and managed correctly according to this invention, the hydrodynamic bearing equipment with which neither oil leakage nor seizure happens can be manufactured.

[0025] Next, based on the measurement flow chart shown in drawing 7 , the procedure of measurement operation of the oil-level position of lubricous oil is explained. Alignment of an outline is first carried out with manual operation. Next, a measurement program is started (S1) and it waits for the set of a work (S2). The lighting illuminance is lowered, in order to consider as the best illuminance for Ath page observation, if a work is set (S3). And the range which explores the focal area A and a focus is set up (S4). Next, the focal position of the focal area A is explored (S5). Focus operation is repeated if needed (S6). In

addition, in the flow chart shown in drawing 7 , automatic-focus operation of Step 5 is set up so that it may repeat 3 times.

[0026] Next, an objective lens is dropped to the neighborhood of a fuel level (S7). And the lighting illuminance is lowered in order to consider as the best illuminance for fuel-level observation (S8). And the range which explores the focal area B and a focus is set up (S9). Next, the focal position of the focal area B is explored (S10). Focus operation is repeated if needed (S11). In addition, in the flow chart shown in drawing 7 , automatic-focus operation of Step 10 is set up so that it may repeat 3 times.

[0027] Next, a lens is raised to nearly A points of the end face of bearing (S12). And a measurement result is calculated per mm and a result is displayed on a CRT screen (S13). The measurement routine consists of the above steps of S2-13.

[0028] Based on a measurement result, it adjusts so that an oil-level position may enter in predetermined tolerance. Although adjustment of an oil-level position can consider two methods, or [whether oil is added from the state without oil in the meniscus, or / sucking out oil, since oil is put in to the limit to A points], which method may be used for it. Under the present circumstances, after performing oil-level adjustment and performing oil-level adjustment on fixed conditions, always measuring an oil level with the measuring method used for this invention, oil-level measurement may be performed and a quality judging may be carried out.

[0029]

[Effect of the Invention] An end face [in / the shaft orientations of bearing / the objective lens of the above-mentioned microscope is moved using the automatic-focus equipment which asks for a focus position from the picture acquired from a microscope in the manufacture method of hydrodynamic bearing equipment according to this invention, and], It asks for each focus position with the oil level of the lubricous oil formed between a shaft and bearing. Ask for the position of the oil level of the lubricous oil to the end face in the shaft orientations of bearing from the position difference of the objective lens in each focus position, and the oil-level position of lubricous oil is written as a position. The hydrodynamic bearing equipment which adjusted the oil level of lubricous oil correctly and managed it can be manufactured, and the hydrodynamic bearing equipment with which neither oil leakage nor seizure happens and whose quality was controlled enough can be obtained.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the cross section showing an example of the motor which can apply the hydrodynamic bearing equipment manufactured by this invention.

[Drawing 2] It is the side elevation showing an example of the meniscus seal section of the hydrodynamic bearing equipment manufactured by this invention.

[Drawing 3] It is the side elevation showing an example of the microscope which can be used for this invention.

[Drawing 4] It is the ** type view showing the example of connection of the measuring equipment which can be used for this invention.

[Drawing 5] It is the ** type view showing an example of a visual field setup of the microscope which can be used for this invention.

[Drawing 6] It is the block diagram showing an example of the measuring equipment which can be used for this invention.

[Drawing 7] It is the flow chart which shows an example of the operations sequence of the oil-level position measurement in this invention.

[Drawing 8] It is the ** type view showing an example of focus operation in this invention.

[Drawing 9] It is the side elevation showing an example of the oil seal section in the conventional oil dynamic pressure motor.

[Drawing 10] (a) in the conventional measuring method is the focus image of the fuel-level soffit section, and (b) is the ** type view of the focus image of the upper-limit side of a sleeve.

[Description of Notations]

1 Shaft

4 Bearing

6 Lubricous Oil

38 Dynamic Pressure Bearing

39 Dynamic Pressure Bearing

51 Microscope

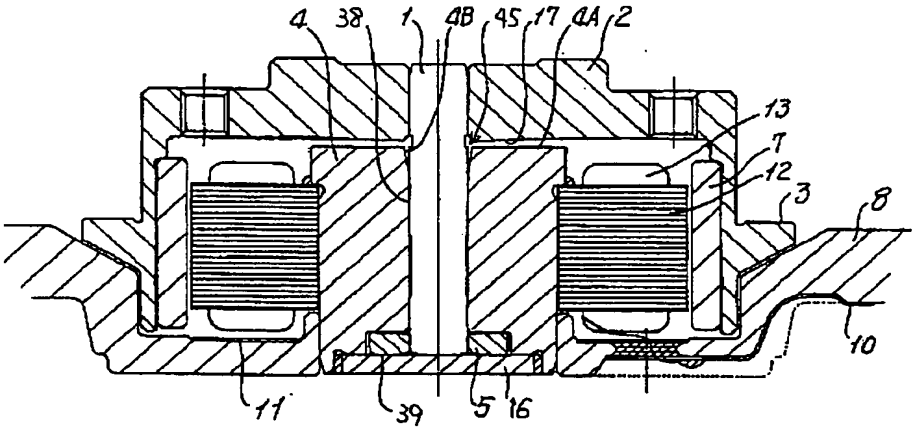
A End face

B The oil level of lubricous oil

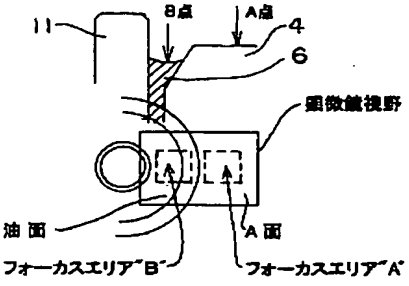
[Translation done.]

DRAWINGS

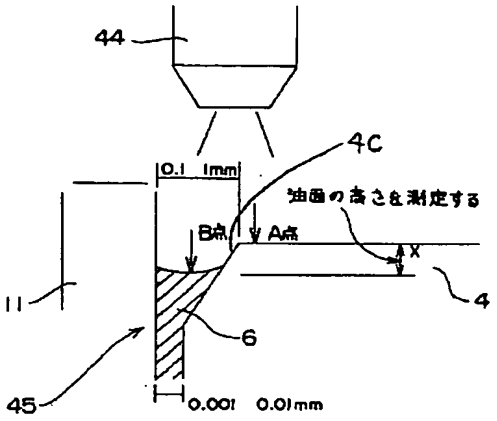
[Drawing 1]



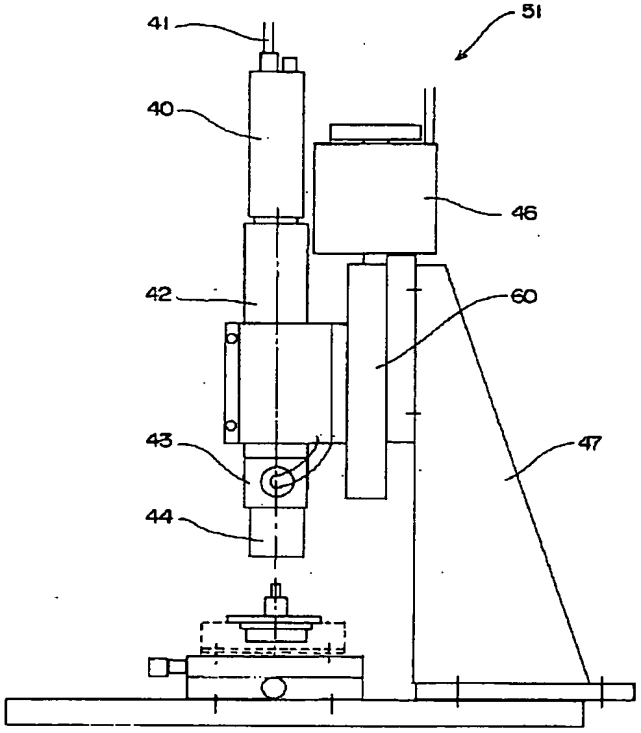
[Drawing 5]



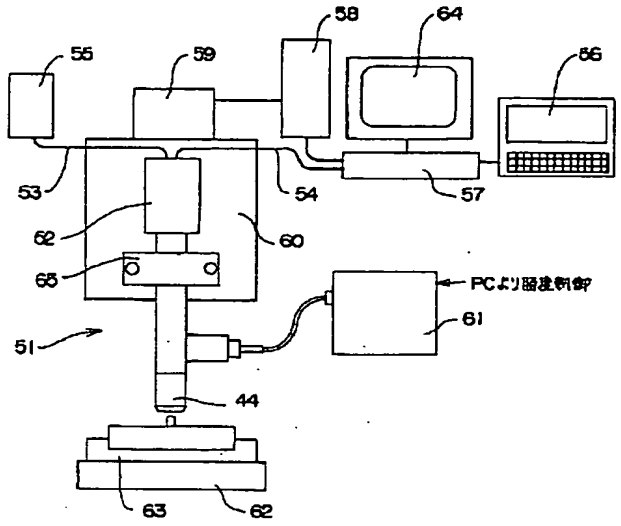
[Drawing 2]



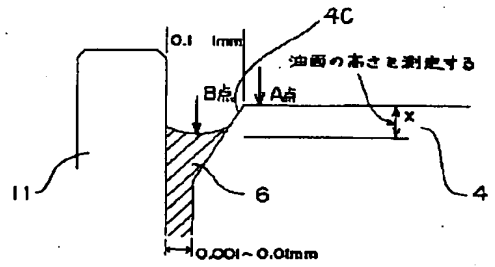
[Drawing 3]



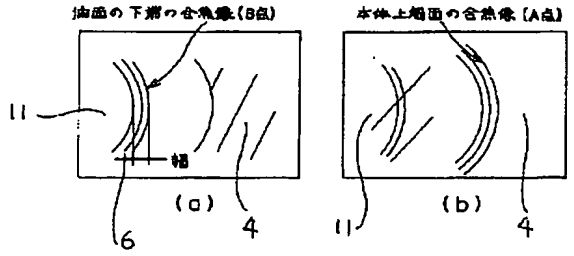
[Drawing 4]



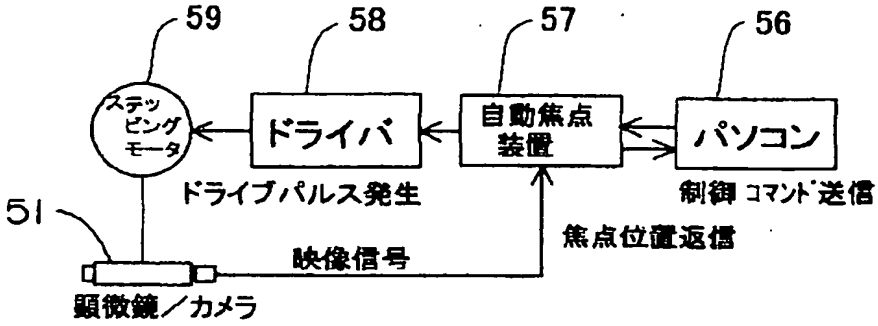
[Drawing 9]



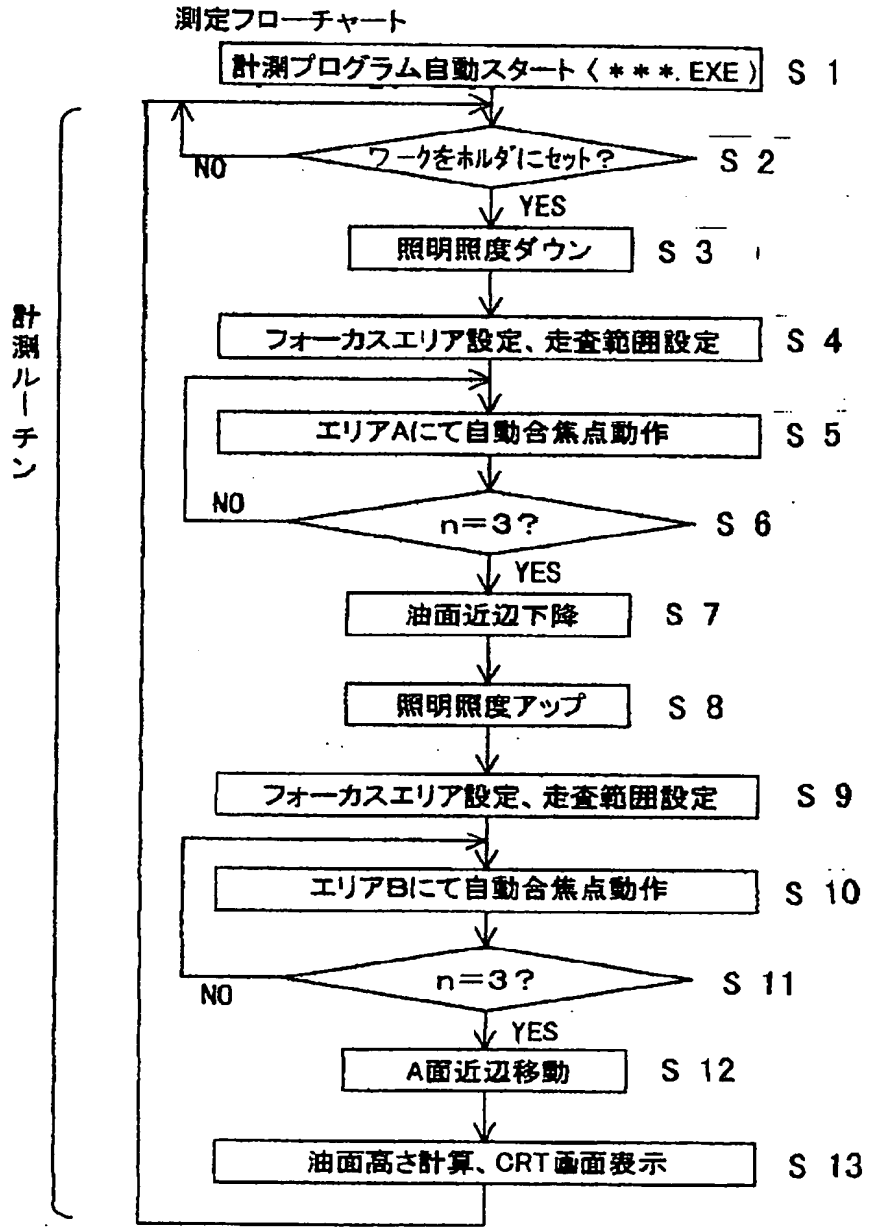
[Drawing 10]



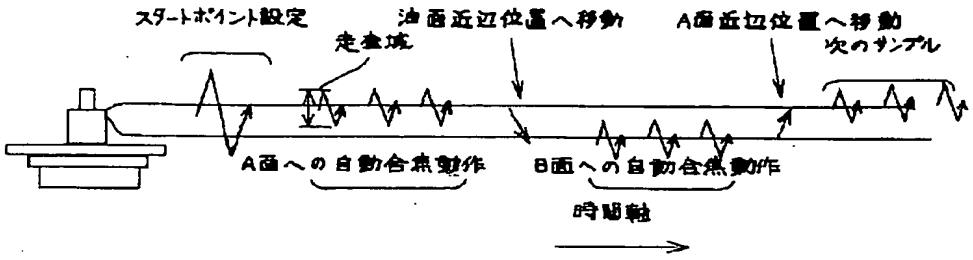
[Drawing 6]


59
58
57
56
ステッピングモータ
ドライバ
自動焦点装置
パソコン
ドライブパルス発生
制御コマンド送信
51
焦点位置返信
映像信号
顕微鏡／カメラ

[Drawing 7]


測定フローチャート
計測プログラム自動スタート（＊＊＊.EXE）
S 1
NO
ワークをホルダにセット？
S 2
YES
照明照度ダウン
S 3
フォーカスエリア設定、走査範囲設定
S 4
エリアAにて自動合焦点動作
S 5
NO
n＝3？
S 6
YES
油面近辺下降
S 7
照明照度アップ
S 8
フォーカスエリア設定、走査範囲設定
S 9
エリアBにて自動合焦点動作
S 10
NO
n＝3？
S 11
YES
A面近辺移動
S 12
油面高さ計算、CRT画面表示
S 13
計測ルーチン

[Drawing 8]


スタートポイント設定
走査域
油面近辺位置へ移動
A面近辺位置へ移動
次のサンプル
A面への自動合焦動作
B面への自動合焦動作
時間軸